

REMARKS

The RCE Transmittal for the above-identified application, filed concurrently herewith, is noted. The present amendments herein constitute the necessary Submission supporting this Request for Continued Examination.

The present amendments herein include amendments which correspond to amendments made in a related application to the above-identified application, Application No. 09/902,673, filed July 12, 2001, which claims priority on the same application, Application No. 09/392,568, filed September 9, 1999, upon which priority is claimed in the above-identified application. Note that in No. 09/902,673, in an Amendment filed after Final Rejection therein, a claim corresponding to subject matter expressly set forth in present claims 31 and 32 was refused entry in therein after final rejection.

In any event, the present amendments further amend the claims of the above-identified application, in order to further clarify the definition of various aspects of the present invention. That is, claim 17 has been amended to recite the step of cleaning the surface of the silicon wafer covered by the insulating film whose main surface is mainly formed of silicon dioxide; and to recite that in removing the insulating film after the cleaning step, the silicon surface of a silicon wafer is thereby exposed. See, for example, Embodiment 1 on pages 12-22 of Applicant's specification, particularly the description on pages 14-17 of Applicant's specification.

In addition, in the present Submission Applicant is adding new claims 31 and 32 to the application. These claims 31 and 32, dependent respectively on claims 17 and 20, expressly recite that the processing solution etches the silicon oxide of the insulating film but does not etch the silicon wafer. Note, for example, the first full

paragraph on page 6 of Applicant's specification.

Applicant respectfully traverses the rejection of his claims on prior art grounds, as set forth in the Office Action mailed July 18, 2002, in the above-identified application, and respectfully submits that all of the claims in the above-identified application patentably distinguish over the teachings of the prior art applied in the Office Action mailed July 18, 2002, that is, the teachings of the U.S. patents to Ohmi, et al., No. 5,990,060 (Ohmi '060), to Wang, No. 6,087,243, to Okutani, No. 5,135,608, and to Ohmi, et al. No. 5,277,835 (Ohmi '835), and Wolf, et al., Silicon Processing For The VLSI Era (Vol.1 1986), pages 198 and 201, under the provisions of 35 USC §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a method of manufacturing a semiconductor integrated circuit device as in the present claims, including, inter alia, wherein the surface of a semiconductor wafer, covered with an insulating film whose main surface is mainly formed of silicon oxide, is cleaned by a sheet-by-sheet manner using a processing solution which contains hydrogen peroxide, hydracid fluoride salt and water, with concentration of this salt being in a range of about 0.1 - 3 mol/l; and, thereafter, removing the insulating film to expose the surface of the semiconductor wafer; and, after removing the insulating film, subjecting the silicon wafer to a heat treatment to form a gate oxide film over the silicon wafer. See claim 17.

That is, as set forth in claim 17, and as will be discussed further infra, it is respectfully submitted that these references do not disclose, nor would have suggested, wherein the surface of a semiconductor wafer covered with an insulating

film whose main surface is mainly formed of silicon oxide, is cleaned by a sheet-by-sheet manner using the recited processing solution; and, thereafter, there is performed a step of removing the insulating film and thereafter forming a gate oxide film over the silicon wafer. It is emphasized that according to present claim 17, the step (b) of cleaning, which is performed prior to gate oxide film formation, is performed using the recited processing solution; and, thereafter, the insulating film is removed; and, thereafter, the step (d) of subjecting the silicon wafer to a heat treatment is performed to form the gate oxide film. That is, as claimed in claim 17, since step (c) follows step (b) and step (d) follows step (c), the step (d) of forming the gate oxide film is performed after the cleaning of the surface of the silicon wafer covered with the insulating film whose main surface is mainly formed of silicon oxide, by a sheet-by-sheet manner, using the recited processing solution.

Special problems arise due to the cleaning processing used prior to forming the gate oxide film, when forming the gate oxide film. The present invention, using the recited processing solution at the time, in sequence, of performing step (b), avoids such problems.

In addition, it is respectfully submitted that the references as applied by the Examiner would have neither taught nor would have suggested such a method of manufacturing a semiconductor integrated circuit device as in the present claims, including, inter alia, the other aspects of the present invention as in the remaining, dependent claims, such as (but not limited to) wherein the hydacid fluoride salt is ammonium fluoride or tetraalkyl ammonium fluoride (note claims 18 and 19, respectively); or wherein the processing solution includes HF and HF₂⁻ as etching seeds of silicon oxide (note claim 20); or wherein the pH of the processing solution is

in a range of 6-11 (note claim 26), in particular, wherein the processing solution further includes a surfactant (see claim 27); or wherein during the step of cleaning, ultrasonic vibration of the processing solution is performed (see claim 23); or temperature of the processing solution during the cleaning as in claim 25; or the additional drying step, after the insulating film is removed and prior to forming the gate oxide film (note claim 29), with the silicon wafer being immediately transferred to a chamber for forming the gate oxide film, after drying (note claim 30).

Moreover, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a method of manufacturing a semiconductor integrated circuit device as in the present claims, having features as discussed previously, and moreover wherein the recited processing solution etches the silicon oxide of the insulating film covering the surface of the semiconductor wafer during the cleaning step but does not etch the silicon wafer. See claims 31 and 32.

The present invention is directed to a method of manufacturing a semiconductor integrated circuit device, advantageously applied to a cleaning process for a silicon wafer in cleaning the wafer prior to forming a gate oxide film of the device.

In manufacturing a large-scale integrated circuit device using a wafer made of mono-crystalline silicon, a so-called RCA wafer cleaning technique has been used, as described in the paragraph bridging pages 1 and 2 of Applicant's specification.

There has been a desire to improve the RCA cleaning technique, and various proposals for improvement thereof have been made, as described on pages 2-4 of Applicant's specification. However, these proposed techniques have been

insufficient, particularly in connection with forming an MOSFET which requires a thin gate oxide film of high quality. See the second full paragraph on page 4 of Applicant's specification. Note also the second full paragraph on page 4, and the paragraph bridging pages 4 and 5, of Applicant's specification, describing problems in connection with these proposed processing techniques. These problems are particularly serious in connection with forming a gate oxide of an MOSFET which requires a thin gate oxide film of high quality.

Against this background, Applicant provides a method having especially advantageous effects for cleaning a semiconductor wafer, in processing prior to forming a gate oxide film of a semiconductor integrated circuit device. Applicant has found that by utilizing a processing solution containing hydrogen peroxide, hydracid fluoride salt and water, the salt being included in an amount of about 0.1 to 3 mol/l, for cleaning by a sheet-by-sheet manner the surface of the silicon wafer covered with an insulating film whose main surface is mainly formed of silicon oxide; and with this insulating film thereafter being removed to expose the surface of the silicon wafer; and the silicon wafer then being subjected to a heat treatment to form the gate oxide film, the cleaning can be performed at relatively low temperatures, and the silicon oxide film is cleaned and etched without etching the silicon substrate, so that contamination of the substrate can be avoided. Moreover, through use of the processing solution of the present invention, in processing steps leading up to formation of the gate oxide film, the cleaning can be accomplished in a short time and at a low temperature, without deteriorating flatness of the wafer surface. Note, for example, the first full paragraph on page 6 of Applicant's specification

It is emphasized that by cleaning the wafers in a sheet-by-sheet manner, the

wafers can be efficiently processed, by a processing technique which cleans the surface of the wafer without etching any silicon exposed at the surface, whereby a good gate oxide film can be formed.

Ohmi '060 discloses a cleaning method and a cleaning device which can remove foreign materials deposited on a substrate after removal of photoresist by plasma processing. See column 1, lines 6-10. This patent discloses that foreign materials can be removed under room temperature, by using a cleaning liquid which is a basic and water-soluble fluoride and an oxidizing agent, mixed in pure water.

Note column 2, lines 20-29. See also column 2, lines 37-39 and 48-51; column 3, lines 42-47; and column 4, lines 45-50. This patent further discloses that by irradiating ultrasonic waves to the cleaning liquid or pure water, it is possible to improve the cleaning effect. Note the paragraph bridging columns 3 and 4 of this patent. This patent further discloses that the cleaning liquid can be applied not only to removal of photoresist, but also to removal of various types of high polymer organic coating films such as paint or adhesive, films of machine oil, as well as removal of surface surfactant or dye or the like. See column 8, lines 24-34. Note also the paragraph bridging columns 2 and 3; and column 5, lines 7-10, of Ohmi '060. This patent, at the above-referred-to portion of column 8, specifically describes that the technique of Ohmi '060 is advantageously used for removing foreign materials deposited and remaining on the substrate even after a photoresist after ion injection and/or reactive ion etching processing used in a semiconductor production process or in the flat display panel production process.

It is emphasized that Ohmi '060 is concerned with a cleaning liquid and cleaning method removing organic materials in general, particularly removal of

photoresist. It is respectfully submitted that this patent is primarily concerned with removal of photoresist in connection with ion injection or reactive ion etching processes, in particular, after formation of the gate oxide and gate electrode. It is respectfully submitted that this patent does not disclose, nor would have suggested, the presently claimed method, including performance of the recited cleaning by a sheet-by-sheet manner using the specified processing solution, prior to forming the gate oxide film, and advantages achieved.

Moreover, it is respectfully submitted that this applied reference does not disclose, nor would have suggested, use of the cleaning liquid disclosed in the patent, in processes (including cleaning), leading up to formation of the gate oxide, or concentration of the hydacid fluoride salt in the processing solution.

It is again noted that according to the present invention, the processing solution used can etch the silicon oxide but does not etch the silicon wafer. Note especially claims 31 and 32. This provides the additional advantage that while cleaning is achieved, a deterioration in flatness of the silicon surface of the silicon wafer can be avoided. Ohmi '060 does not disclose, nor would have suggested, either alone or in combination with the other applied references, this feature of the present invention, achieved by cleaning utilizing the recited processing solution, at the recited point in the sequence of steps as recited in the present claims.

It is emphasized that according to the present invention, the cleaning technique using the recited processing solution is a cleaning step prior to formation of the gate oxide film. Due to requirements of the gate oxide film, the present invention provides certain advantages, including wherein the surface of the silicon wafer is not etched. See especially claims 31 and 32. Therefore, it is possible to

remove contamination without deterioration of the flatness of the silicon wafer surface, for example, so that a gate oxide film with a high quality can be advantageously formed according to the present invention.

In contrast, it is respectfully submitted that Ohmi '060 is concerned with a cleaning step after formation of the gate oxide film and gate electrode. It is respectfully submitted that the cleaning procedure of Ohmi '060 focuses on a cleaning after formation of the gate oxide and after removal of a photoresist mask, and would have neither taught nor would have suggested problems in connection with cleaning prior to forming the gate oxide film, as discussed in the foregoing, and overcoming such problems through use of the processing solution for cleaning as in the present invention. It is respectfully submitted that the purpose and requirements with respect to cleaning prior to formation of the gate oxide film are different from those with respect to cleaning after formation of the gate oxide film; and it is respectfully submitted that Ohmi '060 would have neither taught nor would have suggested the present invention, including cleaning using the recited processing solution as in the present claims, by a sheet-by-sheet manner, prior to formation of the gate oxide film, and advantages thereof.

The contention by the Examiner in the paragraph beginning on page 4 of the Office Action mailed July 18, 2002, that Ohmi '060 "discloses only process steps (or conditions) necessary to clean a substrate utilizing the processing solution" (emphasis in original), is noted. It is respectfully submitted that this is too broad an interpretation of the teachings of Ohmi '060. It is respectfully submitted that Ohmi '060 does not disclose, nor would have suggested, use of the cleaning method described therein prior to formation of the gate oxide film. Particularly in light of the

unique problems arising in connection with forming gate oxide films after cleaning, which problems do not arise in cleaning after formation of the gate oxide film (and after formation of the gate electrode), these problems having been discussed previously, and which problems are overcome by the present invention, the contention by the Examiner with respect to the breadth of the teachings of Ohmi '060, and that the present invention would have been obvious in light of Ohmi '060 describing use of a processing solution in a cleaning process, in general, is respectfully traversed.

Again, it is emphasized that Ohmi '060 specifically describes use of the disclosed processing solution after formation of the gate oxide film and gate electrode, and it is respectfully submitted that Ohmi '060 would have neither taught nor would have suggested use of the disclosed processing solution in general (that is, at any cleaning step in the semiconductor fabrication process).

It is respectfully submitted that, in the involved art, different cleaning solutions are used prior to, and subsequent to, forming the gate oxide film. In connection therewith, note the enclosed Table 7 on page 254 of the publication Cleaning Technology For Silicon Wafer Surface (February 28, 1995). This shows that different cleaning solutions are used in cleaning prior to and after formation of the gate oxide. It is respectfully submitted that this publication constitutes evidence that one of ordinary skill in the art concerned with in Ohmi '060, which reference does not disclose use of the cleaning solution in a cleaning step prior to formation of the gate oxide film, would not have utilized the cleaning liquid described therein, in a cleaning step prior to formation of the gate oxide film.

It is respectfully submitted that the remaining references as applied by the Examiner in the Office Action mailed July 18, 2002, would not have rectified deficiencies of Ohmi '060, such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Wang discloses a method of manufacturing a semiconductor device including trench isolation. In a description of background art, this patent discloses a trench isolation technique including wherein, after the trench has been formed and filled, heating is utilized to densify the trench fill; and the remaining portion of the pad oxide layer is then removed with dilute hydrofluoric acid, followed by an industrial standard "RCA" clean, with a high quality gate oxide then being grown, followed by polysilicon deposition. Note, column 2, lines 9-41. This patent discloses a method of manufacturing a semiconductor device having an active region isolated by an isolation trench, including formation of a second oxide layer, as described in column 3, lines 32-63. This patent discloses that in accordance with the method described therein, a first sacrificial oxide layer is removed, as by etching with dilute HF followed by a surface cleaning treatment commonly referred to as the "RCA" clean, as with a mixture of hydrogen peroxide and ammonium hydroxide or a mixture of hydrogen peroxide and hydrogen chlorite. A second sacrificial oxide is removed, as by etching employing a dilute HF dip followed by the standard "RCA" clean, exposing a fresh silicon surface, with a thin gate oxide layer being formed on this fresh silicon surface.

Note from column 4, line 66 to column 5, line 28.

Initially, it is noted that according to Wang, the sacrificial oxide layer is removed, and thereafter a surface cleaning treatment is performed. It is respectfully submitted that this disclosure of Wang, even in combination with the teachings of

Ohmi '060, would have neither taught nor would have suggested, and would in fact have taught away from, a process wherein the cleaning of the surface using the processing solution is performed, and thereafter the insulating film is removed and thereafter the gate oxide film is formed. That is, while Wang initially removes the pad oxide film and thereafter performs a cleaning, the present invention cleans and thereafter removes the insulating film. Clearly, the teachings of Wang, in combination of the teachings of Ohmi '060, would have taught away from the presently claimed subject matter including wherein cleaning of the surface of the silicon wafer covered with the insulating film whose main surface is mainly formed of silicon oxide is performed in a sheet-by-sheet manner using the recited processing solution, removing the insulating film after the cleaning thereby to expose the surface of the silicon wafer; and after such removing, subjecting the silicon wafer to a heat treatment thereby to form a gate oxide film over the silicon wafer, and advantages thereof as discussed in the foregoing.

The contention by the Examiner on pages 5 and 6 of the Office Action mailed July 18, 2002, that both Wang and Applicant are utilizing a common practice, is respectfully traversed. That is, it is emphasized that according to Wang the "RCA" clean is performed after removal of the sacrificial oxide. Such procedure as in Wang would have taught away from the presently claimed process, including wherein the cleaning is performed and thereafter the insulating film is removed (that is, the cleaning is performed prior to removal of the insulating film).

Okutani discloses thin film-forming technology and etching technology in processing wafers used for semiconductor devices. The patent describes a method of producing semiconductor devices including dry and wet processing steps for the

wafers, and a step for carrying wafers between the dry and wet processing steps, the dry and wet processing steps and carrying step being continuously carried out in a predetermined atmosphere shutting off the open air. See column 2, lines 26-34.

Note also, column 2, lines 42-54; and column 3, lines 57-64.

Even assuming, arguendo, that the teachings of Okutani were properly combinable with the teachings of Ohmi '060 and Wang, such combined teachings would have neither disclosed nor would have suggested the cleaning, subsequent removing and subsequent gate oxide film-forming steps in the recited sequence as in the present claims, with the cleaning using the processing solution as recited in the present claims, and the advantages of this process as discussed previously.

Furthermore, even combining the teachings of Okutani with the teachings of Ohmi '060 and Wang, the combined teachings of these references would have neither taught nor would have suggested the increased efficiency achieved using the processing solution as recited, in cleaning the surface of the wafer by a sheet-by-sheet manner, prior to forming the gate oxide.

The contention by the Examiner that the sheet-by-sheet cleaning process "is not considered to have patentable weight because an apparatus for sheet-by-sheet processing would have been commercially available at the time the current invention was made" (see lines 2-4 on page 4 of this Office Action mailed July 18, 2002), is noted. It is respectfully submitted that whether or not an apparatus was commercially available is not relevant to the issue of obviousness. The Examiner has not even attempted to establish motivation for combining the teachings of Okutani and Ohmi '060. Of course, absent such motivation, the prior art rejection under 35 USC §103, combining teachings of the references, is clearly improper.

The contention by the Examiner that Ohmi '060 teaches that the processing solution (and cleaning process) therein was invented for the very purpose of removing foreign material remaining on the surface of a silicon oxide layer (that is, a pad/sacrificial oxide surface), wherein the foreign material is a direct result of removing a resist mask which had been formed on the silicon oxide surface, is noted. See lines 5-8 on page 6 of the Office Action mailed July 18, 2002. It is respectfully submitted, however, and as emphasized previously, Ohmi '060 does not expressly disclose cleaning using the recited solution, prior to gate oxide formation. Moreover, the examples in Ohmi '060 include cleaning processes after formation of the gate oxide film. In view of different problems involved in connection with cleaning before and after gate oxide film formation, and in view of the clear evidence of record, in the enclosed Table 7, that it was known in the art to use different cleaning solutions before and after gate oxide film formation, it is respectfully submitted that Ohmi '060 provides no suggestion or motivation for using the cleaning solution described therein, prior to the oxide film formation, as in the present invention.

Ohmi '835 discloses a surface treatment agent for use in fine surface treatment which is very effective for wet etching of silicon oxide film in the manufacturing process of semiconductor devices, as well as cleaning of fine-treated semiconductor devices. See column 1, lines 12-18. The surface treatment agent includes a mixed solution of fluoric acid, ammonium fluoride and water, the mixed solution containing specified amounts of hydrogen fluoride and ammonium fluoride. See column 3, lines 17-23.

Even assuming, arguendo, that the teachings of Ohmi '835 were properly

combinable with the teachings of Ohmi '060, Wang and Okutani, as applied by the Examiner, it is respectfully submitted that the combined teachings of these references would have neither taught nor would have suggested the sequence of processing steps, including the cleaning step performed by a sheet-by-sheet manner, using the recited processing solution, particularly which etches the silicon oxide of the insulating film but does not etch the silicon wafer, and thereafter performing the insulating film removing step, and thereafter performing the gate oxide film forming step, and advantages of this sequence using the processing solution as discussed previously.

Wolf, et al. discloses thermal oxidation of single crystal silicon, describing ranges of thermal SiO₂ thicknesses used in VLSI processing and disclosing techniques for forming SiO₂ directly on a silicon surface. Wolf discloses temperatures for thermally forming the SiO₂.

Even assuming, arguendo, that the teachings of Wolf, et al. were properly combinable with the teachings of Ohmi '060, Wang and Okutani, such combined teachings would have neither disclosed nor would have suggested the sequencing of processing steps, and in particular the use of the recited processing solution to clean by a sheet-by-sheet manner, prior to removal of the insulating film, with the gate oxide film thereafter being formed, and advantages of this processing as discussed in the foregoing.

In view of the foregoing comments and amendments, and the concurrently filed RCE Transmittal, withdrawal of the finality of Office Action mailed July 18, 2002, and entry of the present amendments; and examination and allowance of all claims presently in the application, are respectfully requested.

843.37558VX2

Attached hereto is a marked-up version of the changes made to the claims by the current Submission. The changes are shown on the attachment captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 843.37558VX2) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE
IN THE CLAIMS

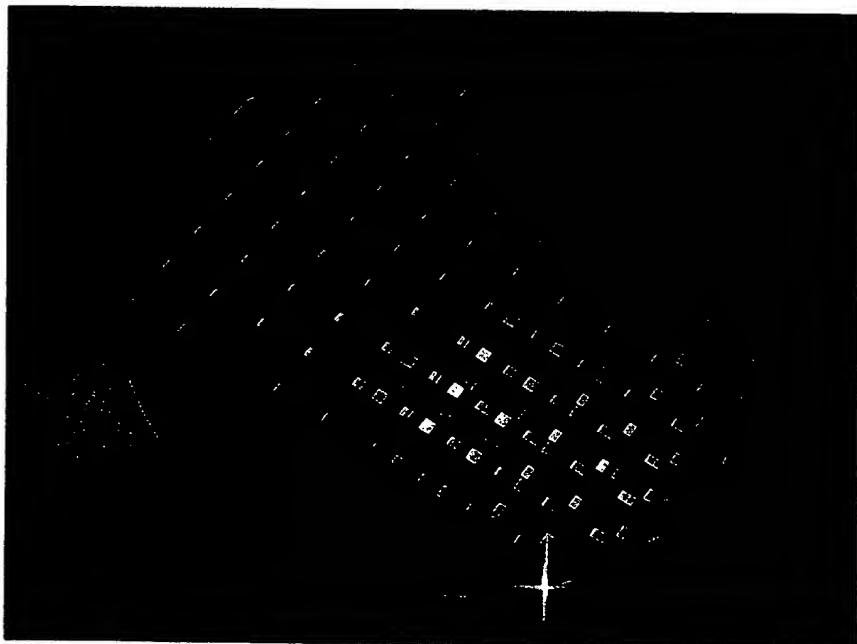
Please amend the claims presently in the application as follows:

17. (Amended) A method of manufacturing a semiconductor integrated circuit device, comprising the steps of:

- (a) providing a silicon wafer covered with an insulating film whose main surface is mainly formed of silicon oxide;
- (b) cleaning the surface of said silicon wafer covered by said insulating film whose main surface is mainly formed of silicon dioxide, by a sheet-by-sheet manner with use of a processing solution containing hydrogen peroxide, hydracid fluoride salt, and water;
- (c) removing said insulating film after said step (b) thereby to expose the silicon surface of said silicon wafer; and
- (d) subjecting said silicon wafer to a heat-treatment after said step (c) thereby to form a gate oxide film over said silicon wafer.

シリコンウェーハ表面の クリーン化技術

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平成7年2月28日 発行

定 價 49,440円
〔本体価格 48,000円〕
〔消費税 1,440円〕

発行所 株式会社 リアライズ社

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発行人 村川順之
編集 廣田住友
制作 土信田裕子

無断複写・転載を禁ず

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ISBN4-947655-75-5 C3055 P49440E

印刷所：瀬味証券印刷(株)

表-7 標準的RCA洗淨法(12)

Hydrogen peroxide-based immersion cleaning procedures for silicon wafers	A. Cleaning and rinsing (if necessary)	1. Remove the photoresist film (if present) by plasma oxidation striping; or immersion in organic photoresist stripper, or with a hot 1:2 v/v H_2O_2 and CO_2 mixture if adequate safety precautions are exercised.	3. Submerge holder with wafers in the cold solution and place the beaters on a hotplate.	4. Heat to 75 to 80°C. Then reduce heating to maintain the solution at 80°C for an additional 10 minutes. (The vigorous bubbling is due to oxygen evolution. Make sure not to boil the solution so as to prevent rapid decomposition of the H_2O_2 and volatilization of the ammonia.)	5. Overflow-quench the solution by placing the beaker under running water for about one minutes.	6. Remove holder with wafers and immediately place it in a cascade water rinse tank for 5 minutes.	C. Stripping of thin hydrous oxide film (1:50 HF+ H_2O)	1. Submerge wafer assembly from step B.6 directly in an agitated mixture of 1 volume hydrofluoric acid (49%, electronic grade) and 50 volumes of water.	2. Allow to remain in the solution for only 15 seconds. Exposed silicon (but not SiO_2) should repel the HF solution ²⁴ . Use a polypropylene beaker for this step.	3. Stir the solution with a clean rod of fused quartz.	D. Removal of residual organic contaminants and certain metals (SC-1)	1. Prepare a fresh mixture of $H_2O-NH_4OH-H_2O_2$ (5:1) by measuring the following reagents into a beaker of fused silica (opaque silica ware is acceptable):	a. 6 volumes of water	b. 1 volume of ammonium hydroxide (29%, electronic grade, w/w% based on NH_3)	c. 1 volume of hydrogen peroxide (30%, unstabilized electronic grade w/w%)	E. Drying of the wafers	1. Transfer the holder with the wet wafers into a water centrifuge.	2. Apply a final water rinse during spinning.	3. Allow to dry while gradually increasing the spinning speed (to avoid aerosol formation from the water droplets).	4. Remove the wafers by dump transfer for high-temperature processing. If single-wafer handling must be used, handle the wafers only at the edge with plastic tweezers.	F. Storage	1. Avoid storage of cleaned wafers, preferably by immediate continuation of processing. If storage is unavoidable, store the wafers in closed glass containers cleaned with hot SC-1 solution, followed by water rinsing and over-drying.	Note concerning processing water and reagents All water used for preparing the reagent mixture or for rinsing should be thoroughly deionized and ultra-filtered, with a resistivity in the 10 to 20-megohm range at 18 to 23 °C. All reagents should be electronic grade, preferably ultrafiltered for freedom from particulate impurities.		
B. Removal of residual organic contaminants and certain metals (SC-1)	1. Rinse with water (see note on water purity for entire processing).	2. Transfer the wafers to a clean Teflon® holder. Pick up wafers with Teflon® or polypropylene plastic tweezers.	3. Transfer the wafers to a clean Teflon® holder. Pick up wafers with Teflon® or polypropylene plastic tweezers.	4. Overflow-quench the solution by placing the beaker under running water for about one minutes.	5. Remove holder with wafers and immediately place it in a cascade water rinse tank for 5 minutes.	6. Remove holder with wafers and immediately place it in a cascade water rinse tank for 5 minutes.	C. Stripping of thin hydrous oxide film (1:50 HF+ H_2O)	1. Submerge wafer assembly from step B.6 directly in an agitated mixture of 1 volume hydrofluoric acid (49%, electronic grade) and 50 volumes of water.	2. Allow to remain in the solution for only 15 seconds. Exposed silicon (but not SiO_2) should repel the HF solution ²⁴ . Use a polypropylene beaker for this step.	3. Stir the solution with a clean rod of fused quartz.	D. Desorption of remaining atomic and ionic contaminants (SC-2)	1. Prepare a fresh mixture of $H_2O-HCl-H_2O_2$ (6:1:1)	by measuring the following reagents into a beaker of fused quartz :	a. 6 volumes of water	b. 1 volume of hydrochloric acid (37% electro-	c. 1 volume of hydrogen peroxide (30%,	unstabilized, electronic grade)	E. Drying of the wafers	1. Transfer the holder with the wet wafers into a water centrifuge.	2. Apply a final water rinse during spinning.	3. Allow to dry while gradually increasing the spinning speed (to avoid aerosol formation from the water droplets).	4. Remove the wafers by dump transfer for high-temperature processing. If single-wafer handling must be used, handle the wafers only at the edge with plastic tweezers.	F. Storage	1. Avoid storage of cleaned wafers, preferably by immediate continuation of processing. If storage is unavoidable, store the wafers in closed glass containers cleaned with hot SC-1 solution, followed by water rinsing and over-drying.	Note concerning processing water and reagents All water used for preparing the reagent mixture or for rinsing should be thoroughly deionized and ultra-filtered, with a resistivity in the 10 to 20-megohm range at 18 to 23 °C. All reagents should be electronic grade, preferably ultrafiltered for freedom from particulate impurities.
C. Desorption of remaining atomic and ionic contaminants (SC-2)	1. Rinse with water (see note on water purity for entire processing).	2. Transfer the wafers to a clean Teflon® holder. Pick up wafers with Teflon® or polypropylene plastic tweezers.	3. Transfer the wafers to a clean Teflon® holder. Pick up wafers with Teflon® or polypropylene plastic tweezers.	4. Overflow-quench the solution by placing the beaker under running water for about one minutes.	5. Remove holder with wafers and immediately place it in a cascade water rinse tank for 5 minutes.	6. Remove holder with wafers and immediately place it in a cascade water rinse tank for 5 minutes.	C. Stripping of thin hydrous oxide film (1:50 HF+ H_2O)	1. Submerge wafer assembly from step B.6 directly in an agitated mixture of 1 volume hydrofluoric acid (49%, electronic grade) and 50 volumes of water.	2. Allow to remain in the solution for only 15 seconds. Exposed silicon (but not SiO_2) should repel the HF solution ²⁴ . Use a polypropylene beaker for this step.	3. Stir the solution with a clean rod of fused quartz.	D. Desorption of remaining atomic and ionic contaminants (SC-2)	1. Prepare a fresh mixture of $H_2O-HCl-H_2O_2$ (6:1:1)	by measuring the following reagents into a beaker of fused quartz :	a. 6 volumes of water	b. 1 volume of hydrochloric acid (37% electro-	c. 1 volume of hydrogen peroxide (30%,	unstabilized, electronic grade)	E. Drying of the wafers	1. Transfer the holder with the wet wafers into a water centrifuge.	2. Apply a final water rinse during spinning.	3. Allow to dry while gradually increasing the spinning speed (to avoid aerosol formation from the water droplets).	4. Remove the wafers by dump transfer for high-temperature processing. If single-wafer handling must be used, handle the wafers only at the edge with plastic tweezers.	F. Storage	1. Avoid storage of cleaned wafers, preferably by immediate continuation of processing. If storage is unavoidable, store the wafers in closed glass containers cleaned with hot SC-1 solution, followed by water rinsing and over-drying.	Note concerning processing water and reagents All water used for preparing the reagent mixture or for rinsing should be thoroughly deionized and ultra-filtered, with a resistivity in the 10 to 20-megohm range at 18 to 23 °C. All reagents should be electronic grade, preferably ultrafiltered for freedom from particulate impurities.
D. Desorption of remaining atomic and ionic contaminants (SC-2)	1. Rinse with water (see note on water purity for entire processing).	2. Transfer the wafers to a clean Teflon® holder. Pick up wafers with Teflon® or polypropylene plastic tweezers.	3. Transfer the wafers to a clean Teflon® holder. Pick up wafers with Teflon® or polypropylene plastic tweezers.	4. Overflow-quench the solution by placing the beaker under running water for about one minutes.	5. Remove holder with wafers and immediately place it in a cascade water rinse tank for 5 minutes.	6. Remove holder with wafers and immediately place it in a cascade water rinse tank for 5 minutes.	C. Stripping of thin hydrous oxide film (1:50 HF+ H_2O)	1. Submerge wafer assembly from step B.6 directly in an agitated mixture of 1 volume hydrofluoric acid (49%, electronic grade) and 50 volumes of water.	2. Allow to remain in the solution for only 15 seconds. Exposed silicon (but not SiO_2) should repel the HF solution ²⁴ . Use a polypropylene beaker for this step.	3. Stir the solution with a clean rod of fused quartz.	D. Desorption of remaining atomic and ionic contaminants (SC-2)	1. Prepare a fresh mixture of $H_2O-HCl-H_2O_2$ (6:1:1)	by measuring the following reagents into a beaker of fused quartz :	a. 6 volumes of water	b. 1 volume of hydrochloric acid (37% electro-	c. 1 volume of hydrogen peroxide (30%,	unstabilized, electronic grade)	E. Drying of the wafers	1. Transfer the holder with the wet wafers into a water centrifuge.	2. Apply a final water rinse during spinning.	3. Allow to dry while gradually increasing the spinning speed (to avoid aerosol formation from the water droplets).	4. Remove the wafers by dump transfer for high-temperature processing. If single-wafer handling must be used, handle the wafers only at the edge with plastic tweezers.	F. Storage	1. Avoid storage of cleaned wafers, preferably by immediate continuation of processing. If storage is unavoidable, store the wafers in closed glass containers cleaned with hot SC-1 solution, followed by water rinsing and over-drying.	Note concerning processing water and reagents All water used for preparing the reagent mixture or for rinsing should be thoroughly deionized and ultra-filtered, with a resistivity in the 10 to 20-megohm range at 18 to 23 °C. All reagents should be electronic grade, preferably ultrafiltered for freedom from particulate impurities.
E. Drying of the wafers	1. Transfer the holder with the wet wafers into a water centrifuge.	2. Apply a final water rinse during spinning.	3. Allow to dry while gradually increasing the spinning speed (to avoid aerosol formation from the water droplets).	4. Remove the wafers by dump transfer for high-temperature processing. If single-wafer handling must be used, handle the wafers only at the edge with plastic tweezers.	5. Overflow-quench as in step 8.5.	6. Continue the rinsing at this stage for a total of 20 minutes in a cascade rinsing system.																			